These results were not sorted by age, therefore, the percentage of 1-2 year old children exceeding 10 μg/dl could not be included in this discussion.

Method 3 Summary Results:
Based upon ATSDR's integrated exposure regression analysis model, residential locations had the following expected blood levels:

Table 3. Estimated blood lead levels for each residence

Upper BPb level in µg/dl	n	Locations
Less than 10	62	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 41, 42, 45, 47, 48, 49, 52, 53, 54, 55, 56, 57, 59, 60, 61, 63, 65, 66, 68, 69, 70, 71, 72, 73, 75, 78, 79, 80
10-14	10	12, 40, 46, 51, 58, 62, 64, 67, 74, 77
15-19	3	15, 43, 76
20-44	3	13, 32, 50
45 & up	2	39, 44

n = number of residences

As noted in Appendix B, this method may be underestimating the number of residences at which blood leads in excess of 10 μg/dl may be seen and thus averages were not calculated. Where possible, actual blood lead levels should be determined. It should be noted that blood lead levels do not address historical exposures or the likelihood of future exposure. The utility of this method is to highlight those residences which are of particular concern and should first receive attention. The ATSDR integrated exposure regression analysis model estimates that 22.5% of 1 - 2 year old children in the Basin may have blood lead levels in excess of 10 μg/dl. This is a fairly reasonable estimate based upon results of blood lead screening in the "Box" which show that blood lead levels in 1-2 year old children is at least twice that of 3-9 year old children (Terragraphics, April 14, 2000). Sixteen percent of 1-6 year old children exceeded 10 μg/dl in the 1999 blood lead screening in the Basin (Terragraphics, April 12, 2000).

It should be noted that while residences 18 and 37 did not show elevated blood lead levels, both of these residences had high concentrations of lead in drinking water samples and merit increased concern.

At the current time, we do not have information to determine how many young children living on

these 80 properties actually participated in the basin blood lead screening. Matching of available residential sampling data with blood lead data of children who have had blood lead testing should be done to confirm the findings of this health consultation. Experience within the Bunker Hill "Box" suggests that young children living on properties containing soil lead concentrations similar to those in the upper ranges of this data set (> 2,000 ppm), are at a high risk of having elevated blood leads. Blood lead levels in children living in the "Box" have been declining as remediation of residential soil proceeds.

Comparisons between the three methods.

As can be seen by a comparison of Tables 1, 2, and 3, all methods were similar in ordering the residences relative to each other. In those residences where the IEUBK model predicted average blood leads to be greater than 10 μg/dl, the IOC was exceeded by 4 or more times. Since the IOC is roughly ½ the dose estimated to result in a blood lead level of 10 μg/dl, based upon this method, exposures at 63 of the 80 residences might be expected to exceed 10 μg/dl. Using the IEUBK model, only 32 residences have estimated average blood lead levels exceeding 10 μg/dl. The ATSDR integrated exposure regression analysis model as used was the least conservative, with only 18 residences having estimated blood lead ranges which exceeded 10 μg/dl. Combined results indicate the need to perform blood lead screening of children in these residences to determine the need for specific intervention and to evaluate the predictive ability of these methods.

Toxicological Implications

Blood lead levels and soil lead levels have been studied together in the Bunker Hill Superfund Site and the Coeur d'Alene River Basin previously. Soil lead was strongly correlated with, and was found to be a significant contributor to, children's blood lead levels in the Bunker Hill Superfund Site (PDHD, ET. AL., 1986). Contaminated house dust was also found to be a major contributor.

Low level exposure to lead primarily affects the central nervous system and blood; however, many parts of the body can be damaged by high exposures to lead (Figure 1). The most severe health effects of lead are not likely to be seen in exposed individuals in the Basin. At lower levels, lead produces subtle neurological effects that can usually only be seen in population based studies.* Effects on neurobehavioral function and reduced vitamin D metabolism have been

*While these subtle effects may not be detected in an individual child, these effects have been seen in studies of larger populations. Based upon these population studies, the Centers for Disease Control and Prevention (CDC) has designated 10 μg/dl blood lead as a level of concern (CDC 1997), however effects would not be expected to show up in individuals until blood lead reaches higher levels

seen at levels between 10 and 20 µg/dl (ATSDR, 1999). While less substantiated, there is evidence of health effects occurring at blood lead levels less than 10 µg/dl. Below 10 µg/dl, decreased IQ, hearing effects, and growth effects have been documented (ATSDR, 1999). A threshold below which lead does not affect IQ in children has not been identified (ATSDR, 1999). Lead has been shown to affect some parameters of heme synthesis at low blood lead levels with no apparent threshold. For more studies and their findings, see Table 2-1 in the Toxicological Profile for Lead (ATSDR, 1999).

At the exposure doses estimated and the blood lead levels modeled from soil and dust lead concentrations, children living within many of the residences sampled under FSPA06 may be at increased risk of subclinical neurobehavioral and developmental effects. Developmental, IQ, and hearing effects have been seen in populations at the doses estimated and blood lead levels modeled in this health consultation. The large number of estimated doses which exceed the IOC indicate a problem with the environmental levels of lead at many of the residences that are the focus of this health consultation. At the exposure doses calculated, effects including decreased motor activity, cardiovascular, hepatic, and reproductive effects have been seen in animal studies (Appendix D; ATSDR, 1999). While there are many difficulties with extrapolating data on animals to humans, these findings suggest additional reason for concern.

It is important to remember that this consult examines young children using typical ingestion rates. Consequently, children experiencing high level lead exposures through atypical activities or pica behaviors (ingesting large amounts of soil) may be at increased risk.

It must also be pointed out that while the dose estimates and modeled blood lead levels in this health consultation considered a number of pathways specific to residential living, there are other pathways within the basin which may add additional lead burdens to the children at these residences. These include exposure to lead based paint, the consumption of contaminated fish, game, or vegetation harvested from the basin, and recreational activities which may result in contact with highly contaminated sediments and soils along the Coeur d'Alene River and Lateral Lakes Chain. Children exposed to these additional sources would be at even greater risk of elevated blood leads.

FSPA 06 also examined the exterior paint of residences for the presence of lead based paint. As can be seen from Appendix A, elevated or even high levels of lead were seen. Lead based paint can be a significant source of exposure to children living in these residences. However, only lead based paint which is in deteriorating condition actually presents a hazard. Lead based paint which is peeling or flaking will result in small pieces which can be directly ingested, or become a component of both exterior surface soil and interior house dust. Lead based paint which is not deteriorating does not present a hazard. Care should be taken to properly maintain the paint in homes constructed prior to 1978, and regular physical examination of painted surfaces should be

performed to identify early signs of deterioration.

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of environmental media. As part of the ATSDR initiative, ATSDR health consultations must indicate whether any site-related exposures are of particular concern for children. At this site, sampling has identified contaminants and lead in the surface soil and indoor dust at residences where children are or will be present. Children are uniquely susceptible to the deleterious effects of lead because they absorb lead more easily than adults do and their body systems are still under development. One and two year old children are the most sensitive to the affects of lead exposure due to their developing nervous system. According to the CDC (1997), 1 to 2 year old children are also more likely to have elevated blood lead levels than children of other ages.

Conclusions

Based on the three methodologies utilized in this health consultation and currently available data, a public heath hazard* may exist for children living at more than half of the residences sampled through FSPA06. Of particular concern are residences 12, 13, 15, 32, 39, 40, 43, 44, 46, 50, 51, 58, 62, 64, 67, 74, 76, & 77. Most of these residences have high soil and/or dust lead levels and should be considered "hotspots" in the basin. Approximately 50 homes had estimated doses twice the IOC and/or estimated blood leads in excess of the CDC action level of 10 µg/dl. While residences 18 and 37 do not rank high due to estimated blood lead levels, both of these residences had high concentrations of lead in drinking water samples and merit increased concern.

Use of the IOC and IEUBK model in this health consultation resulted in a higher estimate of children with elevated blood lead levels than have been seen in the State's Exposure Assessment and annual blood lead screening in the Basin (1999 Basin screening showed 16% of children age 1 - 6 to have blood lead levels greater than 10 μg/dl). This suggests the need to: 1) focus on children one to two years old, 2) match environmental lead levels with actual blood lead levels for children living at these residences, and 3) implement primary and secondary prevention activities in the Basin.

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*The Public Health Hazard category is used for sites that pose a public health hazard due to the existence of long-term exposures (>1 year) to hazardous substances or conditions that could result in adverse health effects. This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.

Overt health effects may not be apparent in individuals at these estimated blood lead levels, but concern is based upon findings of population based studies. Increased hazard is likely if other routes of exposure unaccounted for in these calculations, such as lead based paint, consumption of biota and recreational activities in the basin are a significant route of exposure to lead. Data suggest that children in some of these residences may be at risk for neurobehavioral and developmental effects.

Based on a combination of the methodologies used in this study no apparent public health hazard* exists for children who had estimated exposure doses less than twice the IOC and/or estimated blood leads less than the CDC action level of 10 µg/dl. Increased hazard is likely, however, if significant non-residential sources of lead or deteriorating lead based paint are present.

Significant lead levels in locations other than the residence may lead to increased blood lead levels in children that are not included by examining only residential lead levels. Places such as daycare centers and common use areas should be evaluated along with residences, and other potential exposure pathways such as ingestion of fish and home produce should be evaluated.

Recommendations

For those residences posing a public health hazard, the following is recommended:

1) action should be undertaken to reduce or cease exposure to contaminated soil and indoor dust (primary intervetion). Actions at some residences with the highest lead levels (e.g. Location ID's specified in the Conclusions Section) should be taken as soon as possible.

2) medical surveillance such as blood lead monitoring of all young children should be performed at these residences and continued basin-wide (see Appendix E for CDC recommended follow-up services according to blood lead level).

3) intervention programs (secondary intervention) should be continued in order to minimize lead exposure in children identified as having elevated blood lead levels.

4) where possible, a more detailed assessment of health hazard due to combined exposure to residential and other sources of lead should be conducted.

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*The No Apparent Public Health Hazard category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects. This determination represents a professional judgement based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.

For those residences posing no apparent public health hazard, the following is recommended:

1) due to the presence of other potential sources of lead exposure, medical surveillance such as blood lead monitoring of children should be considered.
2) intervention programs should be continued in order to minimize lead exposures by children identified as having elevated blood lead levels.
3) if blood lead testing indicates a health hazard, other sources of lead should be assessed.

Environmental lead levels should be compared with actual blood lead testing for children living at these residences to identify children needing follow-up and to confirm method results.

Basin blood lead screening data should be evaluated by age.

For all homes constructed prior to 1978, care should be taken to properly maintain the paint in those home and regular physical examination of painted surfaces should be performed to identify early signs of deterioration. Care should be taken during remodeling of these homes to limit exposure to lead based paint.

Perform a health risk evaluation of other metals present at these residences.

Perform an evaluation of all available data and multiple exposure pathways within the Coeur d'Alene Basin, which includes not only residential exposures such as in this document, but also recreational activities, ingestion of fish, schools, daycare centers, common use areas, and lead based paint.

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Appendix A: Coeur d'Alene River Basin Residential Properties
Analytical Results for Lead in Soil, Dust, and Paint.

Location ID	Average Lead Concentration in Residential Yard (mg/kg)		Lead Concentration in Play Area (mg/kg)		Lead Concentration in Garden (mg/kg)		Lead Conc. in Mat	Lead Conc. in Vacuum Bag	Lead Conc. in Exterior Paint	Lead Conc. in Interior Paint	Water Sample Results exceeding RAL/MCL (µg/L) all first-run
	Surface Soil	Sub-surface	Surface Soil	Sub-surface	Surface Soil	Sub-surface	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
1	663	495	-	-	721	592	841	606	30300	409	-
2	804	729	-	-	-	-	797	480	98600	-	-
3	174	132	154	121	-	-	4250	764	-	-	-
4	448	343	-	-	-	-	658	173	-	-	-
5	1190	1100	-	-	-	-	790	978	2390	-	-
6	227	382	-	-	319	475	673	422	-	-	-
7	979	1460	-	-	-	-	588	154	-	-	-
8	290	321	-	-	-	-	300	389	-	-	-
9	665	408	-	-	-	-	15500	765	5300	-	-
10	342	777	-	-	-	-	1020	332	205	-	-
11	760	245	-	-	2440	266	2030	1260	-	-	-
12	3490	6820	-	-	1000	714	2800	604	-	-	-
13	5570	1980	-	-	1080	1210	995	1960	-	-	-
14	794	767	-	-	-	-	4250	1200	-	-	-
15	3790	4260	-	-	-	-	767	-	905	-	-
16	1010	307	-	-	213	218	1660	1660	-	-	-
17	276	236	-	-	-	-	1260	680	-	197	-
18	796	358	-	-	-	-	332	818	-	93	26.4
19	953	1050	-	-	315	473	950	512	-	-	-
20	451	1030	613	747	-	-	1280	639	-	-	-
21	1340	1250	-	-	-	-	3440	1350	-	-	-
22	1690	2760	1120	1290	1120	972	1660	798	130000	-	-
23	977	805	-	-	626	618	734	808	-	-	-
24	813	1190	-	-	257	245	847	703	-	-	-
25	438	153	-	-	-	-	-	84	-	-	-
26	682	886	-	-	-	-	-	762	20600	-	-
27	622	282	-	-	-	-	566	349	-	-	-
28	1320	858	-	-	-	-	2120	767	-	-	-
29	437	474	-	-	-	-	812	383	119	10	-
30	1580	1230	-	-	-	-	1550	1020	4140	86000	-
31	827	627	-	-	-	-	1250	710	-	-	-
32	3600	8570	12100	36100	885	732	1780	1020	-	-	-
33	278	377	-	-	278	693	496	427	783	-	-
34	1420	594	-	-	587	589	1490	1020	949	-	-